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New claims 15-24

1. A method for communicating information symbols in a Direct Sequence Code Division Multiplex communication system (DS-CDMA) including a base station for transmitting a signal including multiple information symbols destined for multiple mobile users simultaneously over a single channel having a channel response, said method comprising:

a) generating a pilot sequence for synchronizing communication between said base and said mobile users and transmitting said pilot signal with said signal over said single channel for receipt by a receiver device at each said multiple mobile user;

b) providing at each user receiver device, an adaptive chip equalizer capable of tracking said channel response;

c) adapting one or more equalizer taps of said adaptive chip equalizer using said received pilot signal at each said receiver device, said adapting for minimizing receipt of information symbol errors; and

e) despreading said signal using a chipping sequence associated with that respective user to extract the information symbols for that user from said single channel.

2. The method for communicating information symbols as claimed in claim 1 wherein a power for a transmitted pilot signal is equal to the power of information symbol sequences transmitted for each mobile user.

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3. The method for communicating information symbols as claimed in Claim 2, wherein as power for a transmitted pilot signal increases, a power transmitted to each mobile user decreases for the same total transmitted power.

4. The method for communicating information symbols as claimed in Claim 1, wherein the step a) includes generating a plurality of pilot sequences each having known chipping sequence and transmitting said plurality of pilot signals simultaneously with said signal over said single channel, said step c) including adapting coefficients of said adaptive equalizer taps of said adaptive chip equalizer using each said received pilot signal.

5. The method for communicating information symbols as claimed in Claim 4, wherein said adapting step c) is performed at a greater speed using when adapting said adaptive chip equalizer based on said received plurality of pilot signals as compared to when adapting based upon a single pilot signal, whereby said plurality of pilot signals enable efficient tracking of fast varying channels.

6. The method for communicating information symbols as claimed in Claim 1, wherein said pilot signal is transmitted continuously, said method thus enabling continuous equalizer adaptation.

7. A Direct Sequence- Code Division Multiplex (DS-CDMA) communication system comprising:

a base station for transmitting a signal including multiple information signals destined for multiple mobile users simultaneously over a single channel having channel response;

mechanism for generating a pilot sequence having known chipping sequence and transmitting said pilot signal with said signal over said single channel subject to a receiver device at each said multiple mobile users;

an adaptive chip equalizer provided at each user receiver device capable of tracking said channel response;

mechanism for adapting one or more equalizer taps of said adaptive chip equalizer using said received pilot signal at each said receiver device, said adapting for minimizing received symbol errors, wherein said receiver de-spreads said signal using a chipping sequence associated with that mobile user to extract the information for that user from said single channel.

8. The DS-CDMA system as claimed in Claim 7, wherein a power for transmitted pilot signal is equal to the power transmitted for each user.

9. The DS-CDMA system as claimed in Claim 8, wherein as power for transmitted pilot signal increases, a power transmitted for each mobile user decreases the same total transmitted power.

10. The DS-CDMA system as claimed in Claim 7, wherein said base station includes means for generating a plurality of pilot sequences each having a known chipping sequence and transmitting said plurality of pilot signals simultaneously said signal over said single channel, said mechanism for adapting one or more taps of said adaptive chip equalizer using each said received pilot signals.

11. The DS-CDMA system as claimed in Claim 10, wherein said adapting mechanism executes at a greater speed using when adapting said adaptive chip equalizer based on said received plurality of pilot signals as compared to when adapting using a single pilot signal, whereby said plurality of pilots enable efficient tracking varying channels.

12. The DS-CDMA system as claimed in Claim 7, wherein said pilot signal is transmitted continuously, said method thus enabling continuous equalization.

13. A method for adapting chip equalizers used for receiving symbols in rapidly fading channels, said method comprising:

a) generating a plurality of pilot sequences each having a known chipping sequence;

b) transmitting said plurality of pilot signals simultaneously with a signal including multiple information symbols comprising data sequences destined for multiple mobile users simultaneously over a single channel,

c) providing at each user receiver device, an adaptive chip equalizer capable of tracking a channel response, and obtaining an equalizer output capable of being processed to obtain a data sequence for a particular user;

d) adapting one or more equalizer taps of said adaptive chip equalizer using said received pilot signals at said receiver device, said adapting for minimizing received information symbol errors; and

e) de-spreading said signal using a chipping sequence associated with a mobile user to extract the information symbols for that user from said single channel.

14. The method as claimed in Claim 13, wherein said adapting step d) comprises the implementing a least squares method comprising steps of:

generating a vector $\underline{a}_{N_p}$ of known transmitted pilot information symbols;

generating a matrix C of pilot spreading sequences; and,

estimating said equalizer taps $\underline{f}_{N_p}$ according to:

$\underline{f}_{N_r} = (X^T X)^{-1} X^T \underline{a}_{N_r}$ where $X = CR$

and where $R(i,j) = r(i + d_f - j)$ $i = 0, \cdots N N_s$, $j = 0, \cdots L_f - 1$
with N_s being the number of received symbols used in estimating the channel response;
and L_f is the total number of equalizer taps.

$\underline{f}_{N_r} = (X^T X)^{-1} X^T \underline{a}_{N_r}$ where $X = CR$

and where $R(i,j) = r(i + d_f - j)$ $i = 0, \cdots N N_s$, $j = 0, \cdots L_f - 1$
with N_s being the number of received symbols used in estimating the channel response;
and L_f is the total number of equalizer taps.

--15. (New) An apparatus for transmitting a communications signal including multiple information symbols destined for multiple users simultaneously over a single channel having a channel response, said apparatus comprising:

a mechanism for generating a pilot sequence having a chipping sequence; and,

a transmitter device for transmitting said pilot signal with said communications signal over said single channel for receipt by a receiver device at said

multiple mobile users, said receiver device including an adaptive chip equalizer capable of tracking said channel response and adapting one or more equalizer taps of said adaptive chip equalizer using said received pilot signal, said adapting for minimizing received symbol errors;

wherein said receiver device de-spreads said communications signal using a chipping sequence associated with that mobile user to extract the information symbols for that user from said single channel.

16. (New) The apparatus as claimed in Claim 15, wherein a power for a transmitted pilot signal is equal to the power transmitted for each user.

17. (New) The apparatus as claimed in Claim 16, wherein as power for a transmitted pilot signal increases, a power transmitted for each mobile user decreases for the same total transmitted power.

18. (New) The apparatus as claimed in Claim 15, wherein said means for generating a pilot signal further generates a plurality of pilot sequences each having a known chipping sequence and transmits said plurality of pilot signals simultaneously with said communications signal over said single channel, said mechanism for adapting one or more equalizer taps of said adaptive chip equalizer using each said received pilot signals.

19. (New) The apparatus as claimed in Claim 1, wherein said adapting mechanism executes at a greater speed using when adapting said adaptive chip equalizer based on said

received plurality of pilot signals as compared to when adapting based upon a single pilot signal, whereby said plurality of pilots enable efficient tracking of fast varying channels.

20. (New) The apparatus as claimed in Claim 15, wherein said pilot signal is transmitted continuously, said receiver device capable of performing continuous equalizer adaptation.

21. (New) A receiver for a communications system capable of receiving a communications signal including multiple information symbols comprising data sequences destined for multiple users simultaneously over a single channel having a channel response, said communications signal including a pilot signal having a known chipping sequence, said receiver comprising:

an adapting chip equalizer used for simultaneously receiving said communications signal and pilot signal, and, obtaining an equalizer output; and

a device for de-spreading said equalizer output to obtain a data sequence for a particular user,

wherein one or more equalizer taps of said adaptive chip equalizer are adapted using said received pilot signal, said de-spreading device de-spreading said communications signal using a chipping sequence associated with that user to extract the information symbols for that user from said single channel.

22. (New) The receiver according to Claim 21, wherein said communications signal includes a plurality of

sequences each having a known chipping seque... for transmission simultaneously with said commun... ...ons signal over said single channel, said adapting chip ...lizer adapting one or more of its equalizer taps ... each said received pilot signal.

23. (New) The receiver according to Claim 2... ...herein said adapting chip equalizer operates at a greate... ...d using when adapting based on said received plural... pilot signals as compared to when adapting based ... single pilot signal, whereby said plurality of pilo... ...ible efficient tracking of fast varying channels.

24. (New) The receiver according to Claim ... ...erein said pilot signal is transmitted continuously fo... ...ing continuous equalizer adaptation.--

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